Advanced Detectors For Gamma-Rays and Neutrons

Introduction

Brookhaven National Laboratory has many years of experience and expertise in building gas filled imaging detectors and large volume scintillation detectors for gamma ray and neutron scattering experiments. These detectors could play a significant role in detecting conventional explosives and locating radioactive nuclear materials using similar gamma ray and neutron detection techniques.

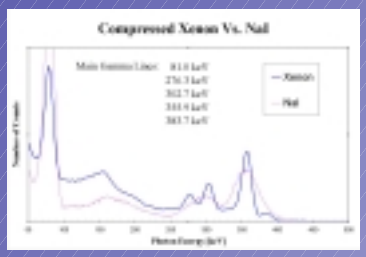
Gamma Rays

Compressed Xenon

Xenon has excellent characteristics for detecting gamma rays:

- High atomic number for high efficiency
- Excellent spectroscopic performance with low power consumption
- Distinguishes between Uranium and Plutonium gamma emissions
- Technology suitable for large area coverage

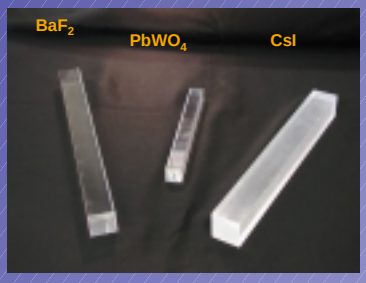
Left: Small, portable, low-power xenon based detector, designed and constructed at Brookhaven



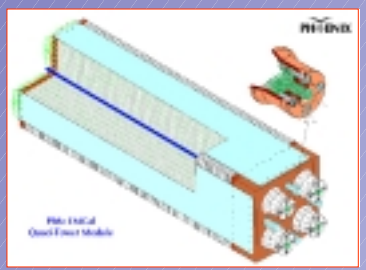
Right: Comparison of Gamma spectra from Xenon detector (blue curve) and NaI (red curve). This illustrates clearly that the resolution in Xenon is much superior to NaI

Scintillating Crystals and Calorimeters

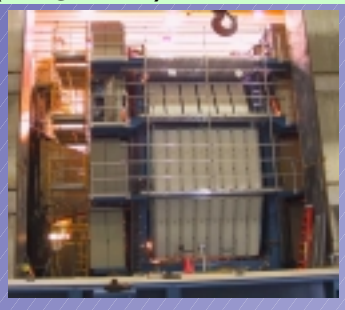
Brookhaven has unique experience in designing and building many types of gamma ray detectors. These include high resolution crystals with various types of photodetector readout and large area sampling calorimeters. Brookhaven also has unique facilities for studying radiation damage (the BNL Gamma Ray Irradiation Facility)



Left: Examples of scintillating crystals that have been developed in collaboration with BNL.



Right: Shashlik calorimeters can achieve DE/E ~ 3.8%/√E(GeV) (12% @ 10 MeV).



Left: Large electromagnetic calorimeters, similar to the one in the PHENIX experiment at BNL's Relativistic Heavy Ion Collider, could provide very large area coverage for gamma-ray detection.

Neutrons

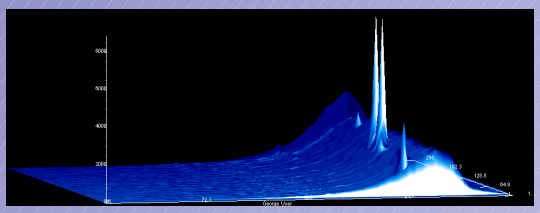
Compressed Helium-3

Neutron detection using ^{3}He offers the following advantages:

- Helium-3 has unsurpassed properties for distinguishing neutrons
- Helium-3 wire chambers offer wide range of possible geometries
- Many applications today in physical and biological sciences

Right: This two dimensional detector has a sensitive area of 1.5m by 20cm and contains 0.25 Megapixels

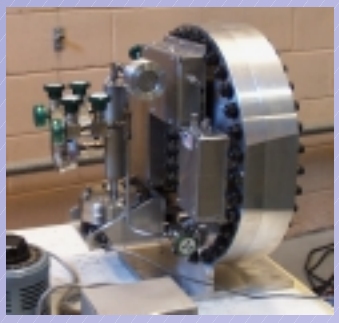
Left: Diffraction peaks projected in time (right to left) from studies of coenzyme of vitamin B12.

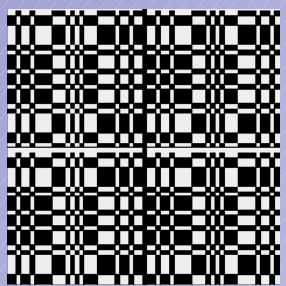


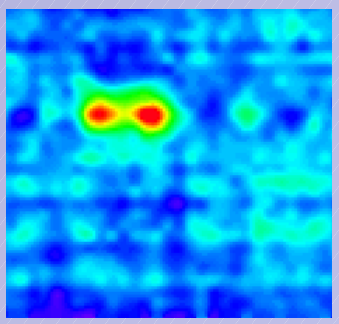
Coded Aperture Imaging

The ability to form images with neutrons opens doors to many applications in arms control and nuclear non-proliferation. Recent BNL developments illustrate that a technique using coded aperture imaging will permit location of neutron emitting material at distances from centimeters to tens of meters.

Right: This BNL detector with sensitive area 20cm by 20cm has been used in conjunction with a coded aperture mask (seen below) for locating neutron sources







Right: Image obtained with two 15cm diameter moderators separated by 45cm viewed at a distance of 300cm

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